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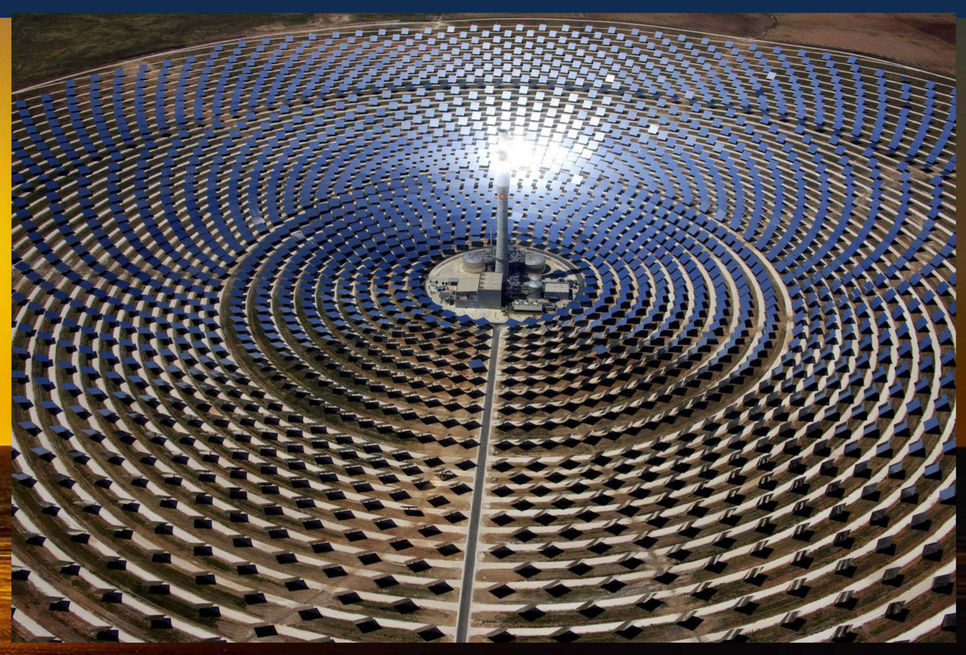
Sandia National Laboratories

Stirling Dish System



Power Tower System

# Phase Change Materials for Thermal Energy Storage in CSP

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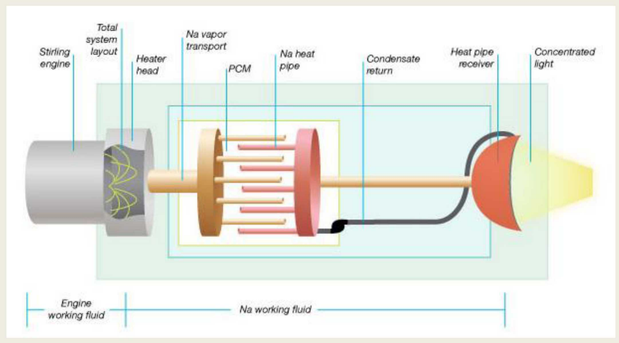
## Background




**Stirling Dish** is one type of CSP which is heavily researched at Sandia. It uses a dish shaped array of mirror to concentrate sunlight onto a Stirling engine (See above figure). Currently, Stirling systems have no ability to store thermal energy.

Recently a mixture of **50% Silicon, 25% Magnesium, and 25% Copper** has been studied for thermal energy storage in Stirling dish applications. In previous tests, mixtures of silicon and copper were found to be very corrosive. The goal of our experiments is to characterize coatings which could prevent corrosion. In addition, thermal cycling tests were conducted to determine if thermal expansion damages the coatings.

## Thermal Cycling Experiments

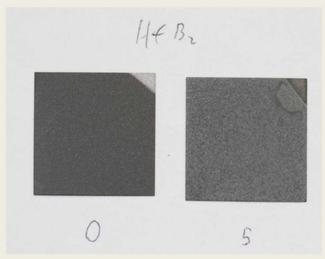



Figure : Color change after 5 thermal cycles

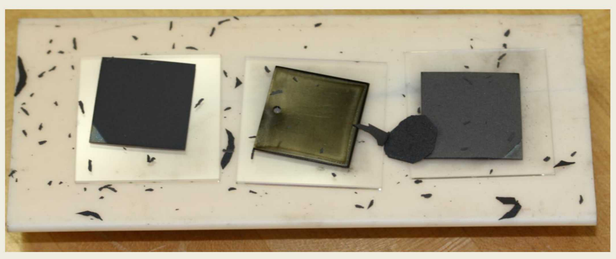
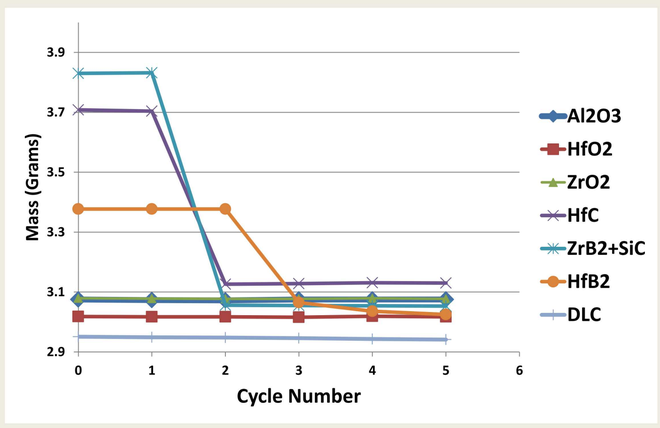


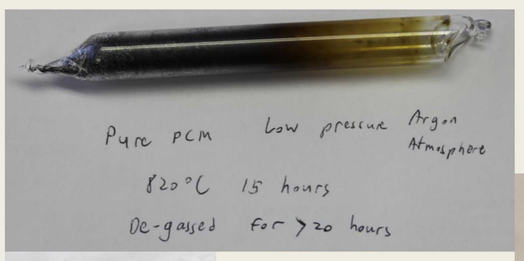
Figure : Picture of flakes of material after severe failure of two coatings.

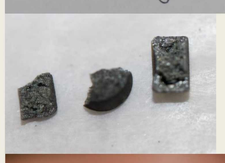
Due to differences in expansion coefficients, mechanical stress can develop in coatings which destroy the coating. To test this, a tube furnace was used to heat the samples to ~820°C. This was done five times, and the mass of the samples was recorded after each cycle.




## PCM Powder Experiments

In order to examine how the coating materials interact with the PCM, powders consisting of the PCM and various coating materials were mixed. The powders were pressed into pellets and sealed in quartz tubes, followed by heating up to 820°C.



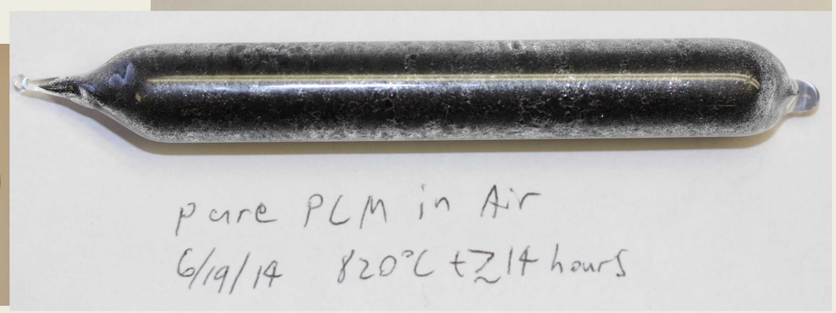



Figure : Various Pictures from PCM test.
Upper Left- Picture of test with vertical tube orientation.
Mid/lower Left: Leftover PCM pellet/tube after air test.
Right: Sealed tube before and after heating to 820°C.

## PCM Powder Analysis

**X-Ray Diffraction (XRD)** was used to analyze the results of heating the PCM to high temperatures. This revealed that the coating on the quartz tube is composed primarily of MgO, with small amounts of other phases. This indicates that the magnesium in the PCM mixture is evaporating/subliming and depositing on the quartz tube.

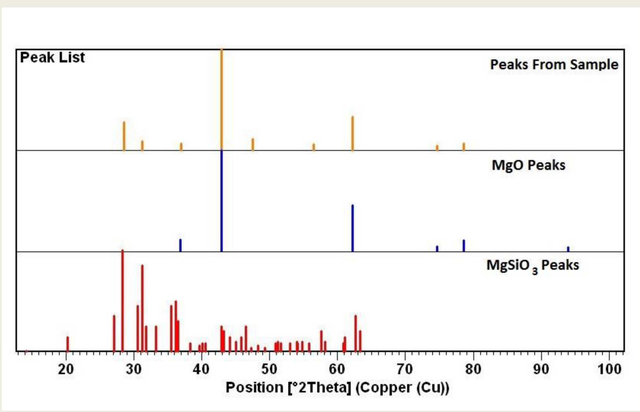



Figure : XRD Peaks from the blue colored wall material

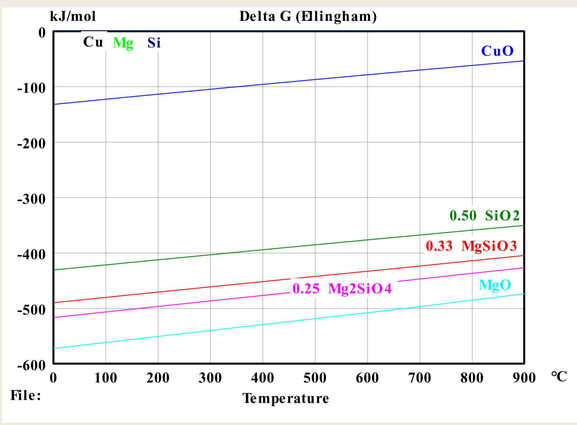



Figure : Gibbs Free Energy of Various Compounds in the System

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